

# (12) UK Patent Application (19) GB (11) 2 302 243 (13) A

(43) Date of A Publication 08.01.1997

(21) Application No 9511914.5

(22) Date of Filing 12.06.1995

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(51) INT CL<sup>6</sup>  
**H04L 12/18 29/06**

(52) UK CL (Edition O )  
**H4P PPG  
U1S S1820 S2205**

(56) Documents Cited  
**EP 0658028 A2 US 4888767 A**

(58) Field of Search  
**UK CL (Edition O ) H4P PPEC PPG  
INT CL<sup>6</sup> H04L 12/18 12/42 12/423 29/06**

## (54) Communication system message acknowledgement

(57) A local communication system comprises a number of stations interconnected for the communication of messages via a serial data channel. A first station transmits a directed type of message to individual ones of the other stations, or transmits a broadcast type of message to all or a subset of the other stations. For a broadcast message, any receiving station unable to accept the message transmits (913) a common negative acknowledgement signal (NAK=1) and the first station re-transmits the message up to five times. Each receiving station when unable to accept a message suppresses (912) generation of the negative acknowledgement signal if the message which cannot be accepted is merely a re-sending of a message previously accepted by the receiving station. In this way, unnecessary communication is avoided, and certainty of communication is increased.

Application is to a car audio system. The medium is wire, optic fibre or radio.

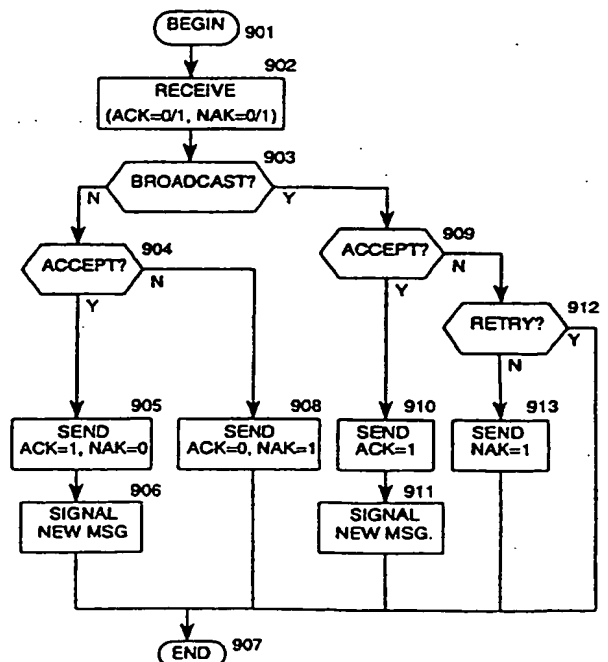


Fig. 9

UD 2 302 243

117

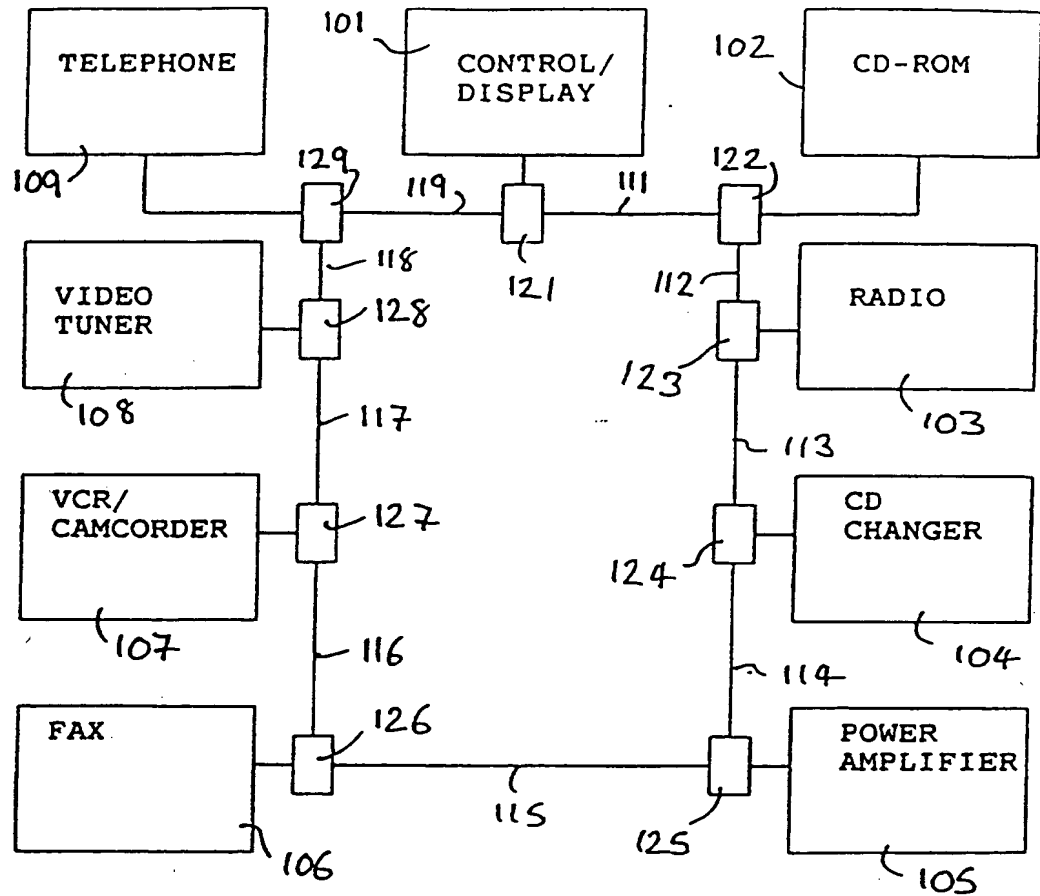
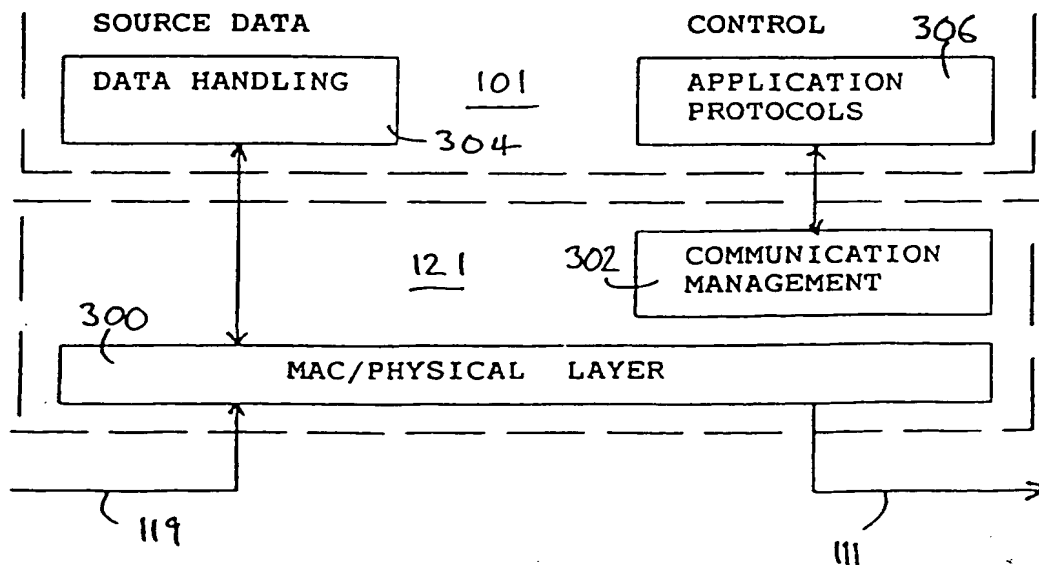


Fig.1

Fig.2



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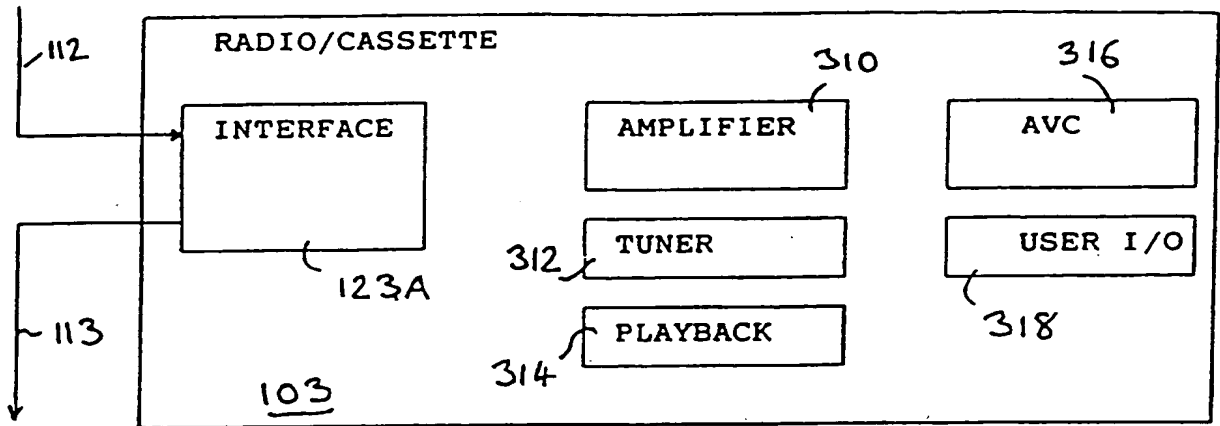


Fig.3

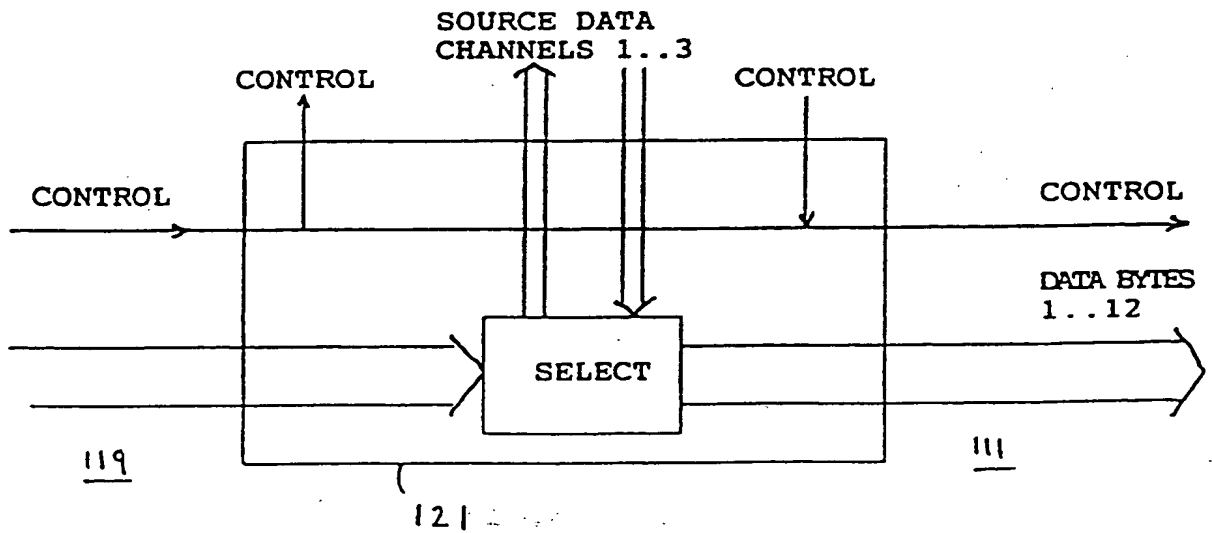


Fig.4

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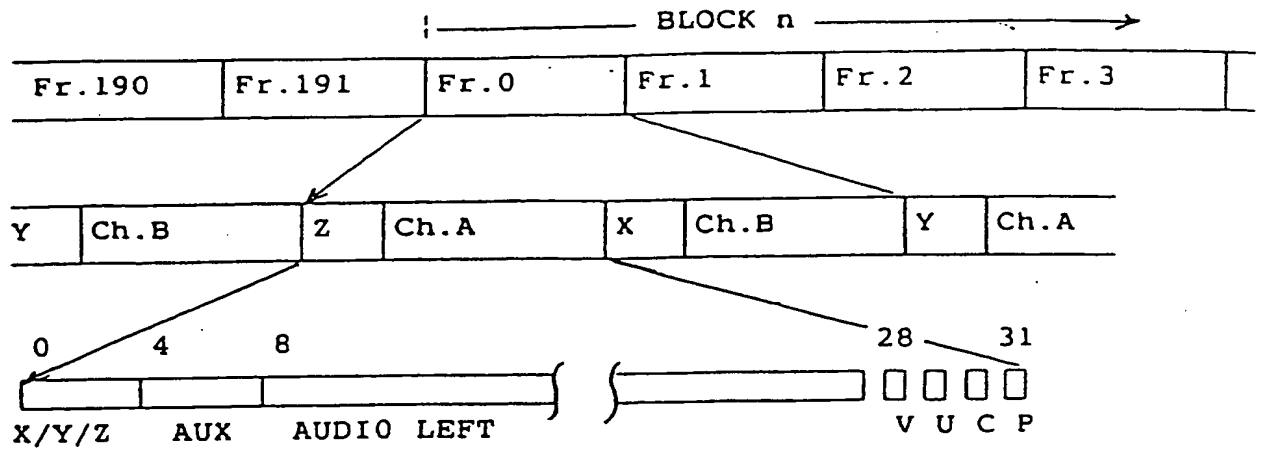


Fig.5 PRIOR ART

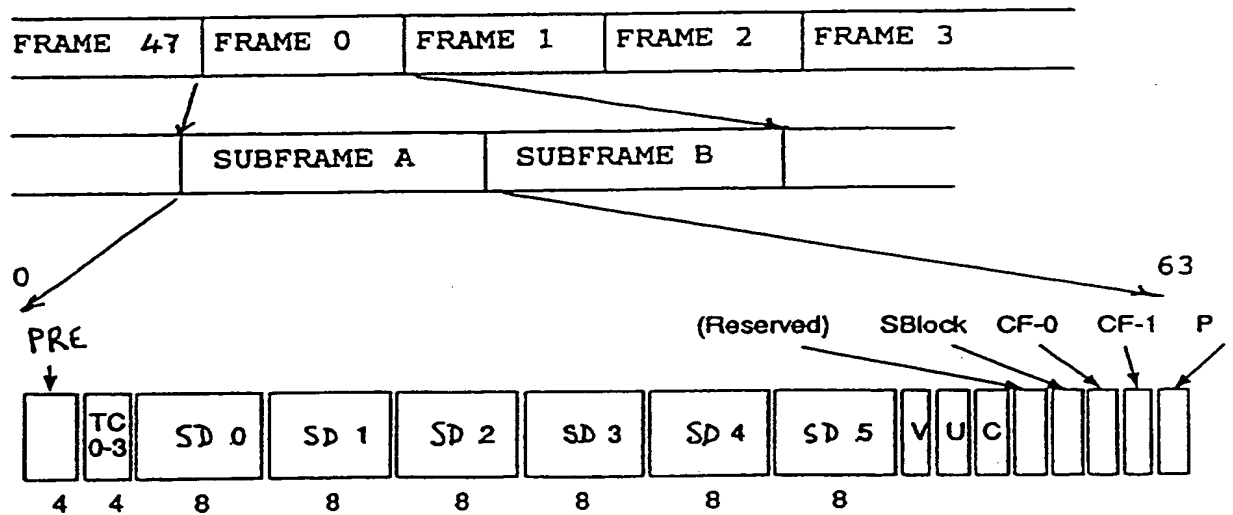


Fig.6

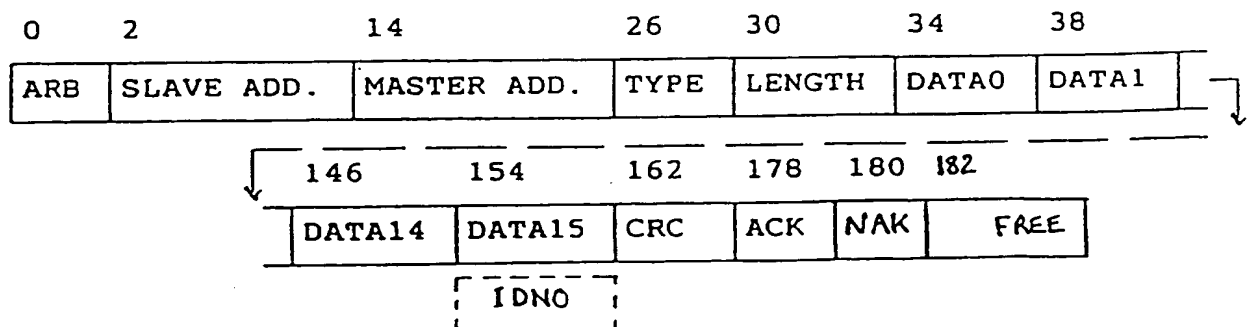


Fig.7

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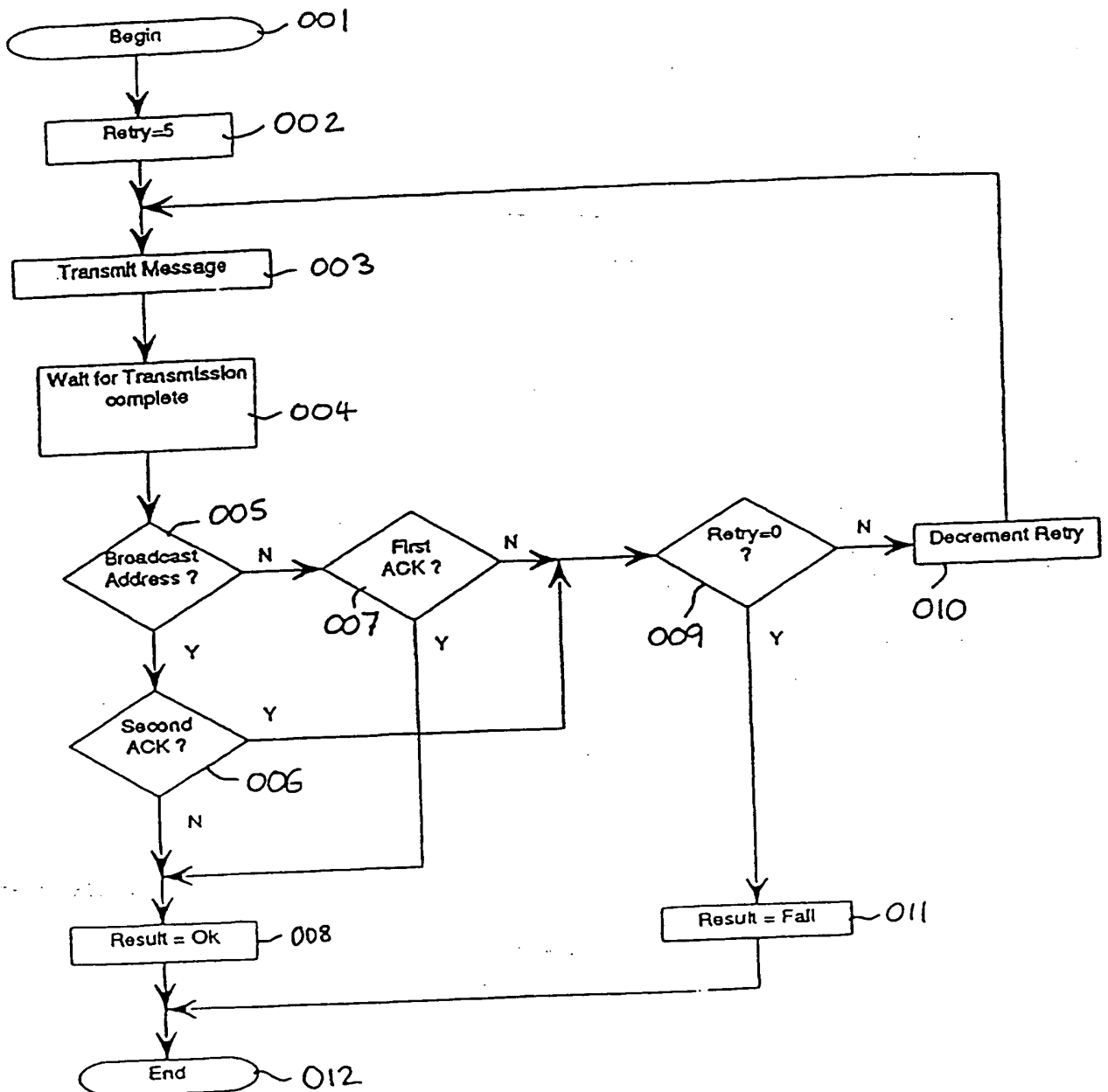


Fig.8

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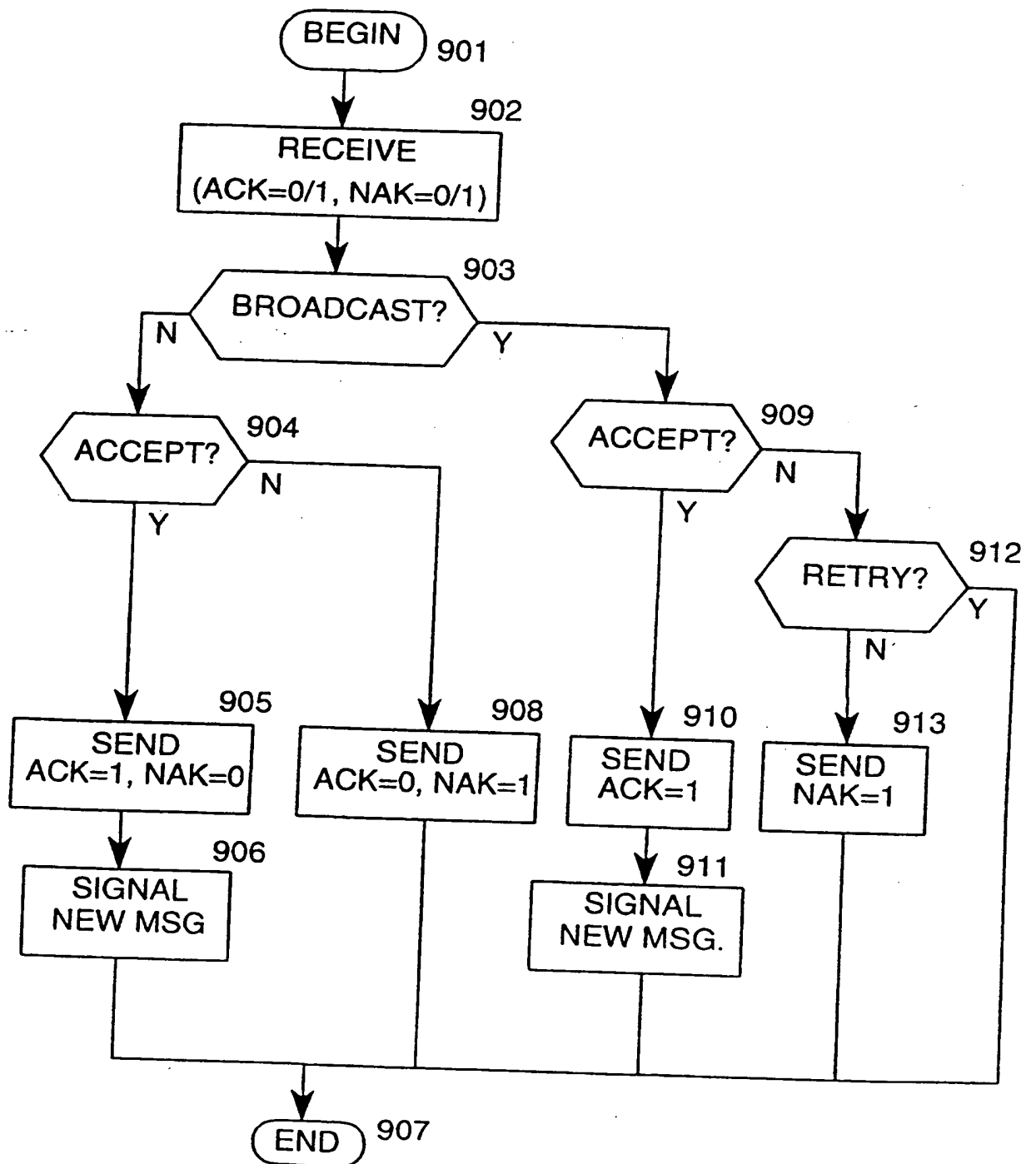


Fig. 9

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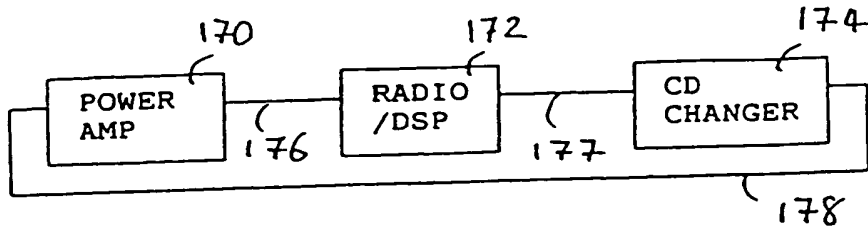


Fig. 10

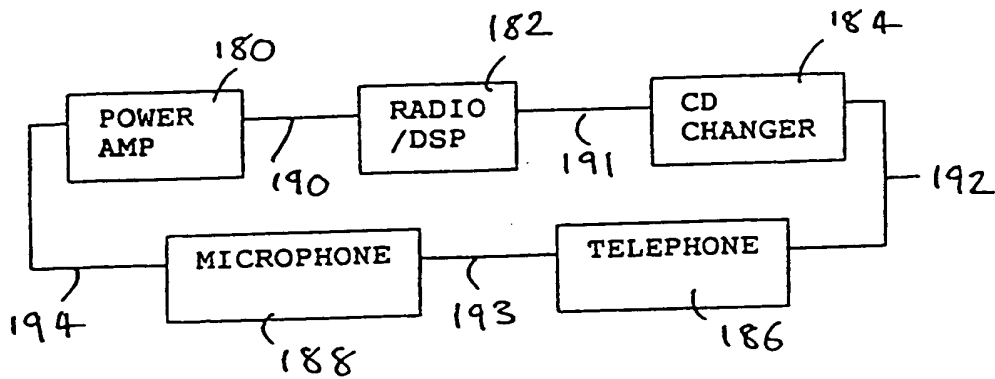


Fig. 11

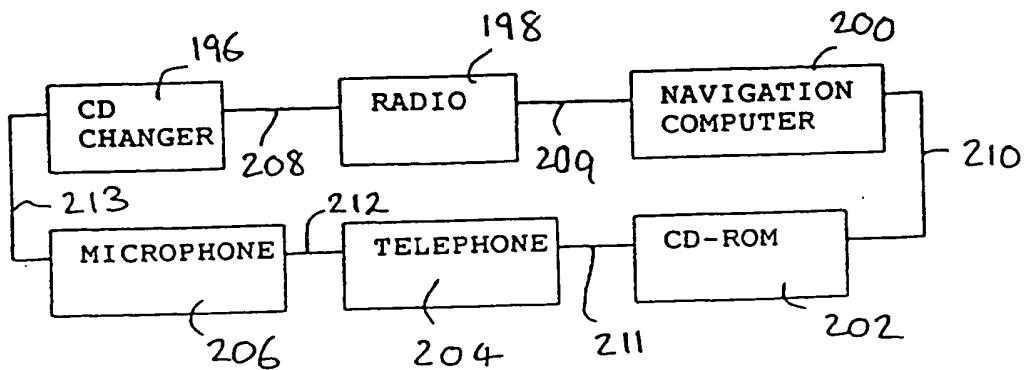


Fig. 12

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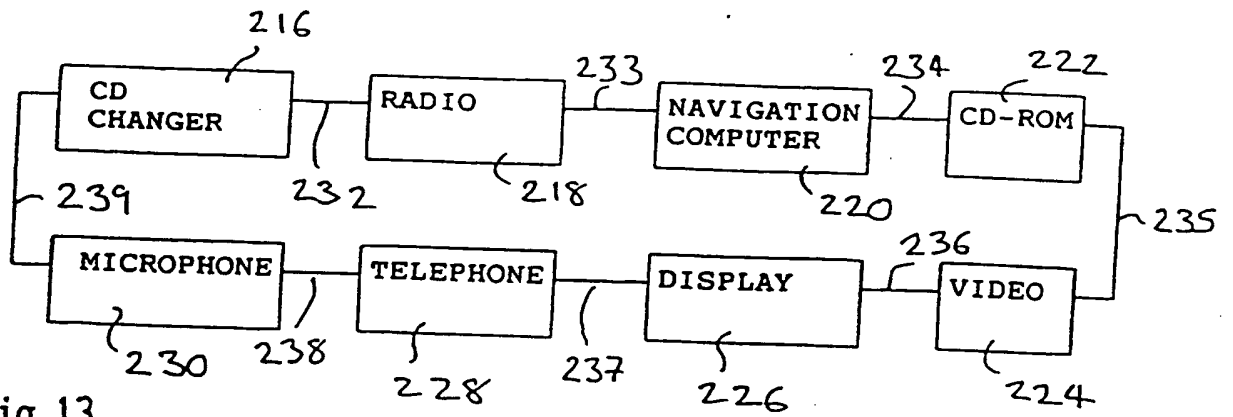


Fig.13



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DESCRIPTION

COMMUNICATION SYSTEM MESSAGE ACKNOWLEDGEMENT

5 The present invention relates to a local communication system comprising a plurality of stations interconnected for the communication of messages via a serial data channel. The invention further relates to apparatuses for use in such a system, and diagnostics apparatus for use with such a system.

10

A system of this type has been described for example by Knapp and Hetzel in a paper "Audio Local Area Network Chip For Cars", presented at the 92nd Convention of the Audio Engineering Society, 24-27 March 1992, Vienna.  
15 Knapp and Hetzel propose use of the well known SPDIF format for the transmission of digital audio signals among the various components of a car audio system, and incorporate within that format eight channels for the transmission of control messages in parallel with the  
20 audio signals.

In the system of Knapp and Hetzel, known as A-LAN for short, each station (each apparatus) is constructed and configured to transmit on a respective one of the eight  
25 control channels, while receiving messages from others of the stations on the remaining seven channels.

Some practical problems arise in the implementation of such a system. Firstly, the allocation of channels as described limits the number of stations connected in the ring network. The reference indicates how one might  
5 exceed this limit by providing multiple rings, with one of the stations acting as a gateway to the other ring. Such a gateway is complicated and costly to implement, however, and effectively increases the cost of adding a ninth station to an A-LAN system.

10

Secondly, each station may find itself obliged to received unrelated messages simultaneously on several channels. This necessitates costly communication management provisions, for example to buffer and  
15 prioritise these messages.

In view of the above, a modified system of the type described has been proposed in UK patent application 9406483.9 (PHQ94006), not published at the present  
20 priority date. The proposed system allows for control messages to be directed to a particular station, or to be "broadcast" for receipt by all stations. In order to prevent the system becoming overcrowded by many individual acknowledgements of a broadcast message, the  
25 proposed system provides only for a negative acknowledgement signal, to be received by the sending station when a broadcast message has not been accepted

by at least one of the receiving stations. On the other hand, for a directly addressed message (sent from one station to a specified one other station), a positive acknowledgement is provided by the destination station  
5 if the message is accepted, and a negative acknowledgement is provided if the message is not accepted. In this way, a sending station is able to differentiate between a message not being accepted by the destination station (for example because it has a full  
10 receive buffer, or the message is corrupted by noise) and the situation where a destination station is not present or is faulty (a major error).

In the system of application 9406483.9, if a negative  
15 acknowledgement is received for a broadcast message, this indicates that at least one of the receiving stations did not accept the message, and the message transmission will be re-tried until no negative acknowledgement is received, up to a maximum of five retries. However, more  
20 retries than necessary will invariably result in such a system, typically up to the maximum number of retries, if one of the receiving stations is unable to accept the original broadcast message. This is because, when the first retry message is transmitted, other stations which  
25 correctly received the original message will be unable to accept the retry message because their receive buffers are occupied by the original message, yet to be

processed.

It is an object of the present invention to reduce the above-mentioned problems with message acknowledgement, while retaining the advantages of the previously proposed system.

The present invention provides a local communication system comprising a plurality of stations interconnected for the exchange of messages via a serial data channel, wherein a first station is operable to send a broadcast type of message to a plurality of other stations including a second station, wherein said second station is operable to perform an acceptance test on a broadcast message and to provide a negative acknowledgement signal to the first station in the event of non-acceptance of the message, wherein the first station is operable to re-send a broadcast message automatically in response to said negative acknowledgement signal being generated by at least one of the other stations, and wherein the second station is arranged not to generate the negative acknowledge signal in the case of a non-accepted received broadcast message which is a re-sending of a broadcast message previously accepted by the second station. By this mechanism, the second station will not provoke unnecessary re-sending of a message which the second station has previously accepted.

The second station may determine whether a received message is a re-sending of a previously accepted message, for example by comparing all or part of a newly-received message with a message already in its receive buffer.

5 Particularly where each message sent by the first station identifies the first station as the source of that message, comparing the whole message will ensure that an identical message received from the same first station is judged to be a re-sending of the message already in

10 the buffer.

In one particular embodiment of the invention, each message further includes a cyclic redundancy check (CRC) word, and the identity between original and re-sent

15 messages is determined simply by comparing the CRC words of a new message and a message already in the buffer.

The first station may further be arranged to identify, within each broadcast message, whether the message is a

20 retry of an earlier message or not. This is achieved in one embodiment of the invention by including in each broadcast message an identification number which is guaranteed to be different from that of the last broadcast message sent by the first station, but which

25 is the same for all re-sendings of a given message. This allows the second station to identify re-sent messages, even when in normal operation the first station may send

a series of otherwise identical messages.

The first station also be operable to send messages of a directed type to respective ones of the other stations.

5 The second station receiving a message from the first station may perform the acceptance test on the message and, if the test is satisfied, provide a positive acknowledgement message to the first station, and, if the test is not satisfied, to provide said negative  
10 acknowledgement message to the first station. The first station may be operable to decide whether or not to resend the message in dependence on the presence or absence of the positive and/or negative acknowledgement signals, and whether the message is a directed message  
15 or a broadcast message.

Each station may include a respective received message buffer and, on receipt by a station of a message, said acceptance test may include a test to determine whether  
20 the message buffer for that station is already full.

The invention further provides an apparatus for use as the second station in a system according to the invention, the apparatus comprising means for receiving  
25 through a serial data channel at least a broadcast type of message intended for plural stations connected to said data channel, and means for generating a negative

acknowledgement signal in the event that a given broadcast message cannot be accepted, the second station further comprising means for suppressing generation of the negative acknowledgement signal, where the broadcast  
5 message is a re-sending of a previously accepted message.

The invention further provides an apparatus for use as the first station in a system according to the invention as set forth above, the apparatus comprising means for  
10 sending broadcast messages to plural station via a serial data channel, and means for re-sending a given broadcast message in response to a negative acknowledgement signal generated by at least one of said plural stations, wherein each broadcast message is identified so as to  
15 distinguish between original messages and re-sent messages.

The present invention further provides diagnostics apparatus for use with a system as outlined above, the  
20 apparatus comprising means for connection to the data channel, event detection means operable to monitor broadcast messages and negative acknowledgement signals, and data handling means operable to process data from the event detection means so as to confirm operation in  
25 accordance with the invention.

Embodiments of the invention will now be described, by

way of example, with reference to the accompanying drawings, in which:

Figure 1 shows in block schematic form a local  
5 communication system embodying the present invention;

Figure 2 illustrates the control and source data architecture used in the system of Figure 1;

10 Figure 3 represents a station with integral interface;

Figure 4 schematically illustrates one of the interface modules of Figure 1;

15 Figure 5 shows the frame structure of digital signals transmitted according to the known SPDIF format;

Figure 6 shows the frame structure of digital signals transmitted between the apparatuses in the system of  
20 Figure 1;

Figure 7 shows the structure of a control frame for use with the message frame of Figure 6;

25 Figure 8 is a flowchart illustrating a message acknowledgment procedure as performed by a transmitting station in the system of Figure 1;



Figure 9 is a flowchart illustrating a message acknowledgement procedure as performed by a receiving station in the system of Figure 1;

- 5 Figures 10 to 13 show various combinations of station types illustrating differing network function.

The system illustrated in Figure 1 comprises nine audio-related apparatuses 101-109 connected as stations (or  
10 nodes) of a Local Area Network (LAN), although it will become apparent from the following description that many more than nine stations may be accommodated. In this example system, the apparatuses are: a control and display unit 101, a Compact Disc memory (CD-ROM) reader  
15 102, a radio tuner 103, a CD changer unit 104, an audio power amplifier 105, a facsimile send/receive unit (FAX) 106, a video recording system (VCR/CAMCORDER) 107, a video tuner 108, and a telephone 109. The display function of the control and display unit 101 may for  
20 example provide for display of information read from memory devices by CD-ROM 102 and/or display of video signals from tuner 108 or VCR 107.

The LAN interconnection comprises nine unidirectional  
25 point-to-point fibre optic links 111-119 linking interface module 121-129, each of which is substantially structurally identical, such that the nodes are all

connected in a ring. Each fibre optic link carries a combination of digital audio/video signals, CD-ROM data and control messages in accordance with a signal frame structure to be described in detail below. A designated station (referred to hereinafter as the system master), such as the control/display unit 101, continuously generates the frame structure at a frame sample rate of 20-50kHz (preferably 44.1kHz as for CD sampling). One station on the network is designated to act as system master on power-up although the role of system master may subsequently be re-allocated to another station.

The data architecture of a station's interface to the fibre optic ring is schematically illustrated in Figure 2. From the ring 119-111, a media access control (MAC)/physical layer 300 (to be described in greater detail hereinafter) together with a communications management layer 302 for control data are provided in interface module 121. The communications management layer 302 manages address initialisation and verification and ensures the reliable transport of messages by retransmission according to defined timing rules. Data handling for source data 304 and application protocols for control data 306 are provided at station level 101, with the application protocols defining the device/subdevice grouping and control hierarchy for the station, the format of information exchanged between

products, the behaviour of devices/subdevices, and application level timing. It will be readily understood that the interface node 121 may be physically within a station. In such a case, whilst a physically separate  
5 entity, it may be considered as a subdevice from a functional point of view as shown in Figure 3, where the interface 123A is provided within a radio cassette player 103 together with amplifier 310, tuner 312, tape playback deck 314, audio/video controller (AVC) 316 and user I/O  
10 318 subdevices. The interconnections of the subdevices are not shown and have no bearing on the present invention, but will be readily apparent to those of ordinary skill in the art.

15 Figure 4 is a schematic representation of an interface node (in this case node 121) linking a station to the fibre optic ring. All stations connected to the LAN can generate and/or receive source data and control data. The control data is of low volume, arrives in bursts and  
20 is user/event driven (e.g. user instructions or status changes), whereas the source data is a continuous high volume stream (e.g. audio, compressed video, CD-ROM data).

25 Software and hardware requirements are reduced in comparison with A-LAN systems as described hereinabove by providing for execution of part of the control and

data channel selection functions in the interface node linking each station to the ring of fibre optic links.

Figure 5 shows the structure of a signal in accordance with the standard IEC 958:1989 of the International Electrotechnical Commission, Geneva, otherwise known as the Sony-Philips Digital Interface Format (SPDIF). The SPDIF signal is designed to transfer digital audio signals on a point-to-point link between two products, typically at frame rates of 32kHz, 44.1kHz and 48kHz. The signal is divided into blocks of 192 frames, each frame comprising two sub-frames of 32 bits. Each sub-frame includes a 20-bit field AUDIO carrying audio signal information, and various control and information bit fields, including a preamble X, Y or Z, auxiliary data field AUX, a validity bit V, a user bit U, a channel status bit C and a parity bit P. The SPDIF specifies the meanings of all these fields, with the exception of user bit U which is left free for use by the designer of a particular system. In the case of the A-LAN system, designed to transfer high quality audio and control signals to a number of products connected in a ring topology, this user bit U is used for system control.

The structure of the message subframe used in the present system is shown in Figure 6. Instead of the repeated 32 bit subframes of the SPDIF arrangement of Figure 5, the

message subframe of Figure 6 is a 64-bit subframe with a 4-bit preamble (indicating left or right channel and block start), four "transparent channel" bits TC0-3, six-bytes (48-bits) of source data (audio, video etc) and  
5 eight further bits. The eight further bits comprise the three SPDIF bits V,U,C a reserved bit, an S-Block bit, two control bits CF-0, CF-1, and a parity bit P.

In order to provide four "transparent" channels for bi-  
10 directional serial communication, to remove the need for a dedicated serial link without requiring an additional microcontroller, the bits TC0-3 of every subframe are reserved for transparent serial communication in four parallel channels. At a sampling frequency of 44.1kHz,  
15 the transparent serial link capacity of the present system is 88.2 kbit/second per channel.

As shown in Figure 6, signals are divided into blocks of 48 successive message frames. At a frame sampling  
20 frequency of 44.1kHz, the control data rate is 176.4kbps giving approximately 920 control frames per second. The control frame is arranged (in the MAC layer; item 300, Figure 2) as shown in Figure 7, providing successive control functions as follows:

25

Arbitration ARB (2-bits): Prevents access to the control message frame by a first station when a preceding station

in the loop has already "taken" the frame (unless the first station is the destination).

Slave Address (12-bits): Address for the destination of  
5 a message. The address is structure in three parts, with  
4-bits identifying the application area (e.g. audio/video  
or telecommunication), 5-bits identifying the device type  
(e.g. amplifier, CD changer, display), and 3-bits  
identifying the device number. As will be appreciated,  
10 this allows for up to eight of each of 32 device types  
in each application area to a total of 4096 addressable  
nodes.

Master Address (12-bits): Address of the message  
15 originating station. Structured as for the Slave  
Address.

Message Type (4-bits): Indicating whether the message is  
directed to a particular station or whether it is a  
20 broadcast message intended for all stations, and other  
attributes of the message.

Message Length (4-bits): Indicates the length in bytes  
of the control message following.  
25

Control Data (128-bits): The control field has capacity  
for a maximum of 16 bytes of control data in a directed

message, although fewer may be carried (see Message Length above). As will be described below, the maximum in the present system is only 15 bytes in the case of a broadcast message, the space for the 16th byte being  
5 occupied instead by an identification number IDNO.

CRC (16-bits): The provision of 16-bits for cyclic redundancy checking provides a high level of reliability.

10 Acknowledge ACK (2-bits): Provides for positive verification of correct receipt of transmitted messages (in direct addressing mode). These bits can be modified by a receiving station and will be examined in their modified form by the transmitting station after passing  
15 round the ring network.

Negative Acknowledgement NAK (2-bits): provides for signalling non-acceptance of broadcast messages, and for signalling device presence even in the event of non-  
20 acceptance of directed messages. These bits can be modified by a receiving station and will be examined in their modified form by the transmitting station.

Free (10-bits): Allowing for specialised functions and/or  
25 expansion of the system. The last two of these are provided to allow a control message frame to be delayed by one subframe, if the message is required to be passed

through the system master, as described in a German patent application DE 19503215.2 (95P10, not published at the present priority date). The remaining bits do not have a specified purpose and will be set to "0".

5

The generation and passing of acknowledgement messages within the system is illustrated by the flowcharts of Figures 8 and 9. The flowchart of Figure 8 shows actions at the transmitting side (first station) and the steps are as follows:

10

Step	Action/Decision
001	Begin
002	Retry=5: Six attempts are permitted for the
15	successful transmission of a message, with a Retry counter being initially set to 5
003	Transmit Message: The originating station begins
20	sending its message either directly to a second station or as a broadcast to a number of stations; both ACK and NAK are reset to '0' in the message as transmitted.
004	Wait: until transmission is completed.
005	Broadcast Address?: When the transmission is
25	complete, a check is made to see whether the message is a broadcast message.
006	Second ACK?: If the message is a broadcast message, a test for non-acceptance is carried out



by the receiving stations; NAK=1 will be set by at least one receiving station if the message is not properly received or cannot be accepted.

- 007 First ACK?: If the message is not a broadcast  
5 message (i.e. it is directly addressed to another station) a test for completeness is carried out; ACK=1 will be set by the receiving station if the message is accepted; NAK will be set to 1 if the message has been recognised but is not accepted.
- 10 008 Result=OK: If the non-completeness test of a broadcast message (step 006) is negative, or the completeness test of a conventional directly-addressed message (step 007) is positive, the message transmission is taken to have succeeded.
- 15 009 Retry=0?: A check is made to see whether the Retry counter has reached zero when the non-completeness test for broadcast messages is satisfied (step 006), or when the completeness test for conventional messages is not satisfied (step 007).
- 20 010 Decrement: Where Retry=0?: (step 009) is negative, the Retry counter is decremented and a further attempt is then made to transmit the message (return to step 003).
- 25 011 Result=Fail: If the retry counter has been reduced to zero without Result=OK (step 008) having been obtained, the transmission is taken

to have failed.

012 End: Completion of the transmit procedure, with a definite result (OK or Fail) having been obtained.

5

Figure 9 shows the corresponding process as performed in a station receiving a control message, as follows:

	Step	Action/Decision
10	901	Begin
	902	Receive message: the interface circuit of the receiving station recognises a control message frame and detects that the message either is addressed directly to this receiving station, or
15		is a broadcast message intended for this receiving station among others. In the form in which the message was transmitted, the acknowledgement bits are reset so that ACK=0 and NAK=0. In the case of a broadcast message,
20		however, stations earlier in the ring network may already have set the bit ACK=1 and/or NAK=1.
	903	Broadcast message? If the message is a broadcast message, control passes to step 909. If the received message is addressed directly to the
25		present receiving station, control proceeds to step 904.
	904	Accept? If the receive buffer of the receiving

station has accepted the new control message, control passes to step 905. Otherwise, control passes to step 908.

- 5           905       Send acknowledge: The control message frame is passed on around the network, with bit ACK set to 1 to indicate correct receipt of the directly addressed message.
- 10           906       Signal new message: The interface circuit informs the functional elements of the receiving station that a new message has been received and is waiting in the buffer.
- 907       End.
- 15           908       Negative acknowledge: If the buffer is full in step 904, bit NAK is set to 1 when the control message frame is passed around the ring, to inform the transmitting station that the message has not been accepted. Control then passes directly to step 907 (End).
- 20           909       Accept broadcast message? If the broadcast message has been accepted into the receive buffer, control passes to step 910. Otherwise control is passed to step 912.
- 25           910       The positive acknowledgement bits of the control frame are set ACK=1 if the message is correctly received and accepted in broadcast mode, but the NAK bits are not modified.
- 911       Signal new message: The presence of a new

message in the received buffer is signalled to the functional elements of the receiving station.

912     Retry?   If the broadcast mode message has not  
5       been accepted, it is determined whether the  
      message is a retry of a message already in the  
      received buffer of the receiving station. If so,  
      control passes directly to step 907 (End).

913     If the broadcast message which has not been  
10      accepted is not a retry of a message already in  
      the receive buffer, a negative acknowledgement is  
      given to the transmitting station, by setting bit  
      NAK=1 when passing on the control message frame  
      to the next station in the ring network. Control  
      then passes to step 907 (End).

15

In the above manner, the embodiment avoids unnecessary  
retries at the transmitting station by suppressing the  
negative acknowledgement signal, when a message cannot  
be accepted which is merely a retry of a message already  
20     correctly accepted in the received buffer. Otherwise,  
      it might be found that retry messages tend to be rejected  
      by many stations, simply because the receive buffers of  
      those stations are occupied by an earlier sending of the  
      same message. In such a case, it might arise that the  
25     maximum number of retries are unnecessarily performed,  
      and that incomplete reception of the broadcast message  
      is incorrectly assumed by the transmitting station, when

in fact all stations have correctly received the message. Suppressing the negative acknowledgement in the case of retry broadcast messages therefore avoids unnecessary communication and communication management overhead in  
5 the stations of the network.

Various implementations are possible for step 912, which determines whether a broadcast message received is a retry of a message already in the received buffer. A  
10 particular method implemented in the present embodiment is simply to compare the CRC (cyclic redundancy check) bits of the new message and the message already in the buffer, since these will be different if the content of the message and/or the identity of the transmitting  
15 station have changed. In systems where transmitting stations will often wish to send a series of identical messages to receiving stations, retries can be distinguished from original messages by providing a message identification IDNO within the message, which is  
20 the same for all retries of a message, but is guaranteed to be different from the IDNO included in the preceding broadcast message from the same transmitting station. As illustrated in Figure 7, the field IDNO can replace the last data byte (bits 154 to 161) in the control  
25 message frame. It will be appreciated that for broadcast messages the number of bytes that can be transmitted per control frame is accordingly one fewer than for directly

addressed messages. The identification number IDNO can be generated automatically for broadcast messages by the interface circuit, although for example using a simple counter within the interface circuit, which is  
5 incremented each time a broadcast message is set. Of course, other mechanisms for distinguishing between retry messages and original messages can be implemented.

Broadcast messages may be distinguished by a particular  
10 TYPE field and/or by the use of a particular destination address in bits 2-13 of the control frame. "Group broadcasting" can also be implemented in which only a certain class of receiving station will respond to a particular group broadcast message. For example, it may  
15 often be desirable to send audio volume change messages to a number of amplifier subdevices distributed throughout the network, without burdening the communications management of other stations. A group broadcast address for amplifier subdevices can be  
20 defined, and used for this purpose.

Examples of how the available source data byte space may be used will now be described with reference to Figures 10 to 13. The interface at each station provides three  
25 input ports and three output ports for source data, and, subject to the maximum source data capacity of 12 source data bytes per frame, each port can be configured for

example to carry 1\*8, 2\*8, 2\*16, 2\*24 or 2\*32 bits per frame. Where a station is required to conform to SPDIF protocols, one of the ports can provide the SPDIF information (V, C, U) to be carried within the message frames (Fig. 6). The bit S-block indicates SPDIF block boundaries, every 192 message frames.

Figure 10 shows an audio system comprising power amplifier 170, radio/digital signal processor (DSP) 172, and CD changer 174 joined by fibre optic links 176-178. Source bit utilisation is:

CD changer -> Radio/DSP	2*16-bit
Radio/DSP -> Power amplifier	2*16 or 2*24-bit

15

Figure 11 shows an audio-telephone system comprising power amplifier 180, radio/DSP 192, CD changer 184, telephone 186, and microphone 188 joined by fibre optic links 190-194. Source bit utilisation is:

20

CD changer -> Radio/DSP	2*16-bit
Radio/DSP -> Power amplifier	2*16-bit
Telephone -> Radio/DSP	2*8-bit
Microphone -> Telephone	2*8-bit

25

Figure 12 shows an audio-telephone-navigation system comprising CD changer 196, radio 198, navigation computer

200, CD-ROM reader 202, telephone 204, and microphone 206 joined by fibre optic links 208-213. Source bit utilisation is:

5                   CD changer -> Radio                   2\*16-bit  
                   Telephone -> Radio                   2\*8-bit  
                   Microphone -> Telephone               2\*8-bit  
                   CD-ROM -> Navigation computer 2\*16-bit

10   Figure 13 shows an audio/video-telephone-navigation system comprising CD changer 216, radio 218, navigation computer 220, CD-ROM reader 222, video player (e.g. video CD player) 224, display device 226, telephone 228, and microphone 230 joined by fibre optic links 232-239.  
 15   Source bit utilisation is:

                  Audio: CD changer -> Radio  
                   or Video: Video CD -> Display       2\*16-bit  
                   Telephone -> Radio                   2\*8-bit  
 20                   Microphone -> Telephone           2\*8-bit  
                   CD-ROM -> Navigation computer 2\*16-bit

It will be appreciated that the above examples are not exhaustive but serve only to illustrate how the 96-bit  
 25   (6 bytes per subframe) frame data capacity may be used.

It will be appreciated that the present invention is not



limited to the particular embodiment described above, but  
can be applied wherever plural devices are required to  
signal negative acknowledgement through a shared channel.  
The fibre optic ring network can be exchanged for a  
5 single bus wire, or for a wireless communication medium.

For compactness of implementation, when ACK=0 is detected  
(step 007:N), meaning that a message has not been  
successfully transmitted, the first station in the above  
10 embodiment does not react any differently depending on  
the state of the NAK bit. However, it is possible as  
described above to distinguish between the case (NAK=1)  
where the message is recognised but not accepted by the  
destination station and the case NAK=0 where the  
15 destination station appears not to exist (NAK=0), and to  
take action specifically appropriate to each case.

From reading the present disclosure, other modifications  
will be apparent to persons skilled in the art. Such  
20 modifications may involve other features which are  
already known in the design, manufacture and use of local  
communication systems, electronic apparatuses and  
component parts thereof and which may be used instead of  
or in addition to features already described herein.  
25 Although claims have been formulated in this application  
to particular combinations of features, it should be  
understood that the scope of the disclosure of the

present invention also includes any novel feature or any novel combination of features disclosed herein either explicitly or implicitly or any generalisation thereof, whether or not it relates to the same invention as  
5 presently claimed in any claim and whether or not it mitigates any or all of the same technical problems as does the present invention. The applicants hereby give notice that new claims may be formulated to such features and/or combinations of features during the prosecution  
10 of the present application or of any further application derived therefrom.

## CLAIMS

1. A local communication system comprising a plurality of stations interconnected for the exchange of messages via a serial data channel, wherein a first station is operable to send a broadcast type of message to a plurality of other stations including a second station, wherein said second station is operable to perform an acceptance test on a broadcast message and to provide a negative acknowledgement signal to the first station in the event of non-acceptance of the message, wherein the first station is operable to re-send a broadcast message automatically in response to said negative acknowledgement signal being generated by at least one of the other stations, and wherein the second station is arranged not to generate the negative acknowledgement signal in the case of a non-accepted received broadcast message which is a re-sending of a broadcast message previously accepted by the second station.

20

2. A system according to claim 1 wherein said second station includes a receive buffer for temporary storage of receive messages prior to processing thereof, and wherein said acceptance test includes a test whether the received buffer is occupied by a previously received message awaiting processing.

25

3. A system according to claim 1 or 2 wherein the second station determines whether a received message is a re-sending of a previously accepted message by comparing at least part of a newly-received message with  
5 at least part of a previously received message.
4. A system according to claim 3 wherein each message includes an error protection word dependent on the entire effective message content, and wherein the second station  
10 determines whether a newly received message is a re-sending of a previously received message by comparing the error protection words of the newly received message and the previously received message.
- 15 5. A system according to any preceding claim wherein the first station is arranged to identify within each broadcast message, whether or not the message is a retry of an earlier message.
- 20 6. A system according to claim 6 wherein a message identification word is included in each broadcast message, the message identification word being the same for all re-sendings of an original message, and being different to a last broadcast message of the first  
25 station, irrespective of the effective message content.
7. A system according to any preceding claim wherein

the first station is also operable to send messages of a directed type to respective ones of the other stations.

8. A system according to claim 7 wherein the second  
5 station receiving a directed message from the first station is arranged to perform the acceptance test on the message and, if the test is satisfied, to provide generate a positive acknowledgement signal.
- 10 9. A system according to claim 8 wherein the first station is operable to decide whether or not to resend the message independence on the presence or absence of the positive and/or negative acknowledgement signals, and whether the message is a directed message or a broadcast  
15 message.
10. A system according to any preceding claim wherein the serial data channel is provided by a succession of unidirectional data links connecting the stations in a  
20 ring network.
11. A system according to any preceding claim wherein said negative acknowledgement signal is generated by modifying a predetermined field within a message frame  
25 conveying the message transmitted by the first station.
12. An apparatus for use as the second station in a

system according to any preceding claim, the apparatus comprising means for receiving through a serial data channel at least a broadcast type of message intended for plural stations connected to said data channel, and means  
5 for generating a negative acknowledgement signal in the event that a given broadcast message cannot be accepted by the apparatus, the second station further comprising means for suppressing generation of the negative acknowledgement signal, where the broadcast message that  
10 cannot be accepted is a re-sending of a previously accepted message.

13. An apparatus according to claim 12 further comprising all of the second station technical features  
15 of a system according to any of claims 1 to 12.

14. An apparatus for use as the first station in the system according to any of claims 1 to 12, the apparatus comprising means for sending broadcast messages to plural  
20 other stations via a serial data channel, and means for re-sending a given broadcast message in response to a negative acknowledgement signal generated by at least one of said plural stations, wherein each broadcast message is identified so as to distinguish between original  
25 messages and re-sent messages.

15. An apparatus according to claim 14 having all the

first station technical features of a system according to any of claims 1 to 12.

16. An apparatus combining all of the first station and  
5 second station technical features of a system according to any of claims 1 to 12.

17. A diagnostic apparatus for use with a system according to any of claims 1 to 12, the apparatus  
10 comprising means for connecting to the data channel, event detection means operable to monitor broadcast messages and negative acknowledgement signals, and data handling means operable to process data from the event detection means so as to confirm operation in accordance  
15 with said claim(s).

18. A local communication system substantially as described herein with reference to the accompanying drawings.



Application No: GB 9511914.5  
Claims searched: 1-18

Examiner: Keith Williams  
Date of search: 12 March 1996

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.O): H4P (PPG, PPEC)

Int CI (Ed.6): H04L 12/18, 12/42, 12/423, 29/06

Other:

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
A,P	EP 0658028 A2      A T & T Corp. - 14 June 1995 - see column 6, lines 1-11	
A	US 4888767          NEC Corp. - see column 4, lines 3-19	

X Document indicating lack of novelty or inventive step  
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P Document published on or after the declared priority date but before the filing date of this invention.  
E Patent document published on or after, but with priority date earlier than, the filing date of this application.